

DTMF CONTROLLER INTERFACE



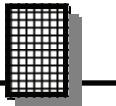
Ramsey Electronics Model No. DCI2

Have you ever wished you could call home and turn on the lights late at night before you pull in the driveway?

Finally, an easy way to remotely control just about anything with the touch of a button! The DCI2C offers control of up to 16 devices using your touch tone phone or any audio signal with DTMF tone signals. User programmable configuration provides latched or non-latched outputs, secure or non-secure access, as well as continuous control of up to 16 devices independent of configuration. A binary format output provides easy control of up to 16 devices.

Key Features

- 6 user configurable modes
- Continuous 1 of 16 lines decoding of all 16 DTMF tone pairs
- Security feature for binary output decoding of all DTMF tone pairs
- Binary output configurable to latch on tone reception or active only with tone in either secure or non-secure mode
- Crystal controlled DTMF decoder.
- Input may be from any DTMF tone source (phone line or other clean audio source)
- Audio filtering to reject normal telco signals other than DTMF tones
- Special configuration mode to provide remote control of Ramsey Electronics DVMS voice messaging system



RAMSEY TRANSMITTER KITS

- FM100B Professional FM Stereo Transmitter
- FM25B Synthesized Stereo FM Transmitter
- TV6 Television Transmitter

RAMSEY RECEIVER KITS

- FR1C FM Broadcast Receiver
- AR1C Aircraft Band Receiver
- SR2C Shortwave Receiver

RAMSEY HOBBY KITS

- SG7 Personal Speed Radar
- SS70A Speech Scrambler
- BS2C "Bullshooter" Digital Voice Storage Unit
- AVS10 Automatic Sequential Video Switcher
- ECG1C Electrocardiogram Heart Monitor

RAMSEY AMATEUR RADIO KITS

- DDF1 Doppler Direction Finder
- HR Series HF All Mode Receivers
- QRP Series HF CW Transmitters
- CW7 CW Keyer
- CPO3 Code Practice Oscillator
- QRP Power Amplifiers

RAMSEY MINI-KITS

Many other kits are available for hobby, school, Scouts and just plain FUN. New kits are always under development. Write or call for our free Ramsey catalog.

DCI2C INSTRUCTION MANUAL

Ramsey Electronics publication No. MDCI2 Rev 1.1

This Printing: March 2009

COPYRIGHT 2008-2009 by Ramsey Electronics, LLC, 590 Fishers Station Drive, Victor, New York 14564. All rights reserved. No portion of this publication may be copied or duplicated without the written permission of Ramsey Electronics, LLC. Printed in the United States of America.

KIT ASSEMBLY AND INSTRUCTION MANUAL FOR

DTMF CONTROLLER INTERFACE

TABLE OF CONTENTS

Introduction	4
Circuit Description	4
Parts Layout Diagram.....	7
Parts List.....	8
Learn As You Build.....	9
DCI2C Assembly	11
Initial Testing	15
Schematic Diagram	18
Case Assembly.....	20
Functionality Description	21
Configuring Your DCI2	21
Configuration Sequence Tables	23,25
Output Signal Description.....	24
DVMS Configuration.....	26
Wiring & Custom Applications	28
Troubleshooting Guide	30
DCI2C Specifications	32
Warranty	35



RAMSEY ELECTRONICS, LLC

590 Fishers Station Drive
Victor, New York 14564
Phone (585) 924-4560
Fax (585) 924-4555
www.ramseykits.com

INTRODUCTION

The DCI2 (DTMF Controller Interface) is designed to meet the needs of the home automation experimenter. The easy hookup interface and simple operation lends itself well to a variety of applications. The DCI2 can be configured by the user to operate in several different modes to meet your specific requirements.

A coded binary set of outputs provides either a latched or non-latched data output mode. A special configuration is also provided to interface to the Ramsey Electronics DVMS, (Digital Voice Message System), to allow messages to be selected and played using DTMF tones. All configurations may be operated in a secure or non-secure mode.

A set of 16 active low outputs are also provided. These operate independently of the DCI2 configuration and provide continuous monitoring of the input signal. Any valid DTMF tone activates a corresponding output for as long as the tone is present.

The DCI2 continually monitors your phone line, or just about any other audio source, listening for any Dual Tone Multi Frequency (DTMF) signals. Another name for these signals is Touch Tones. When the DCI2 detects a valid signal it decodes it and performs the appropriate actions.

We'll now explain in more detail these actions and how the DCI2 operates.

CIRCUIT DESCRIPTION

Take a look at the DCI2C's Schematic Diagram as we walk through the circuit description. We will start with the DTMF audio input and work our way through to the power supply section.

The Input

The DTMF audio input uses a standard RJ-11 modular phone jack (J6 - Phone Line Monitor In) for easy interfacing with your phone line or other audio source (a direct audio pinout for J6 is shown in the "WIRING AND CUSTOM APPLICATION SUGGESTIONS" section of this manual. The input circuitry near the phone jack allows the DCI2 to continually monitor the audio signal and detect any DTMF data that comes in so it can be decoded. The audio sniffer formed by C14, C15, R8, R9, and R10 presents a high impedance to the input signal. This allows connection to the phone line without making it think the phone is off-hook so it will not capture the line and does not interfere with the normal use of your phones. Protection diodes D2 and D3 limit the incoming signal to +/- 0.7 V so that potentially damaging voltages like the 90 Vp-p 'Ring' signal do not damage the decoder IC. Capacitor C11 blocks any DC potential that may be present from reaching U3's input on pin 2 thru R3.

The DTMF Decoder

The DTMF decoder, IC U3, a Holtek HT9170B, has the task of monitoring all the input audio signals. When a valid DTMF signal is received, it sets a 4 bit digital code on output pins 11, 12, 13, and 14.

Why a 4 bit code you may ask? Think back to your high school math class for a moment when you learned about different base numbering systems. Humans like to work in a base 10 system (decimal system, deci = 10) using the digits 1 through 10 (or 0 through 9 to be more precise). This is probably due to the 10 fingers and 10 toes we all learned to count on as kids. Computers on the other hand (pardon the pun) like to work with a base 2 numbering system (binary system, bi = 2) using digits 0 and 1; 0 for off / low and 1 for on / high. In order to represent the 16 different possible tones (base 10) you need to have 4 bits in a binary system $2^4 = 1111$ (binary) = 16 (decimal). Wow... kind of got off on a tangent there!

Internally, U3 has a set of counters that latch the 4 outputs depending on the detected tones. The counters are referenced to a television color-burst crystal operating at 3.579 MHz (X1) for rock solid measurements. Notice how C1 couples a bit of the X1 crystal frequency over to U1 (the micro-controller) to set its timing as well.

The Micro-controller

U1 is a pre-programmed Freescale (Motorola) MC68HC908JK3 micro-controller. This IC contains the software required to take the DTMF tone data from U3 and process it while reading and writing to FLASH memory, generating the feedback tones, monitoring the programming switch, and performing all the output functions of the DC2. It does all this according to how you have configured the DCI2. Don't forget that it also handles all the configuration set-up you do when you first start programming your DCI2. We won't go into all the functions of U1 because each of the configurations have different signal input and output requirements. You can think of it as the traffic controller for the DCI2. Quite a bit for one little part!

One other important signal line between U3 pin 15 and U1 pin 7 is the data valid signal. Whenever U3 detects a valid DTMF signal it sends a high level signal on this line to tell the microprocessor it needs to look at the 4 data lines and make a decision what to do with the data. This signal line is also used by U2 which will be discussed next.

The 4 to 16 Line Decoder

As you can see the DCI2 actually has two major "brains". The DTMF decoder U1 and the microprocessor U3. There is one more smart device we need to talk about and that is U2, a 74HC154, a 4 line to 16 line decoder. If that sounds

familiar think about the output of U3, a 4 line signal that represents the DTMF signal received and then the 16 different DTMF signals. You guessed it, U2 constantly looks at the 4 output lines from U3 and sets one of it's 16 outputs to a low level, whenever the data valid signal is activated from U3, based on which DTMF signal was received. While this device is not as complex as U1 and U3 it is still important. This circuit functions all the time no matter how the DCI2 has been configured. This means that you can always tell which DTMF signal is received. One of the 16 output lines will be activated, set to a low level, whenever a valid signal is received. The 4 data input lines are on pins 20, 21, 22 and 23 of U2 and the data valid signal, supplied thru Q7 to pin 19. Q7 is necessary because the data valid signal is the opposite level of what U3 provides. It simply inverts the level so a the high level from U3 for data valid is changed to a low for use by U2.

Other Information

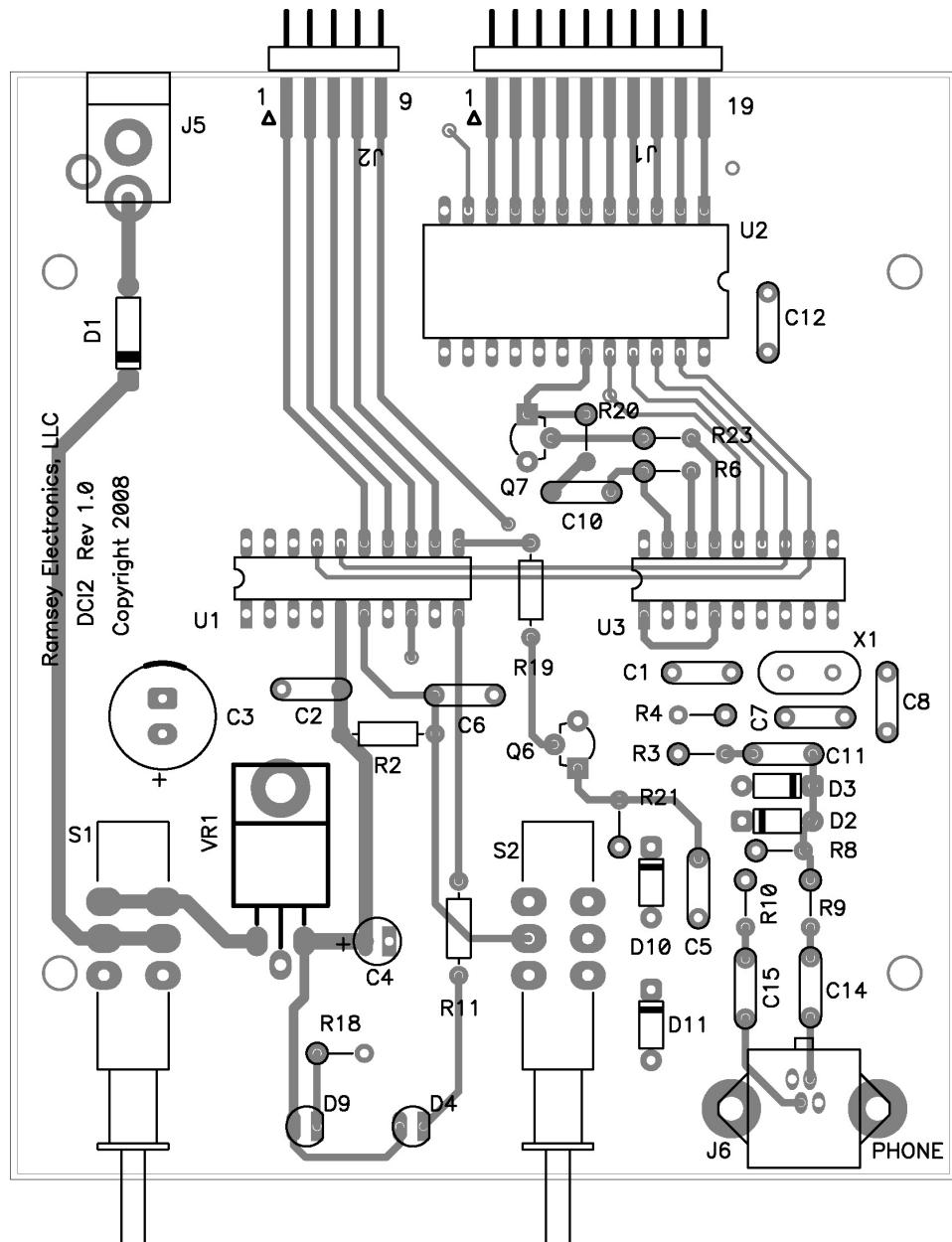
When the micro-controller, U2, receives valid data from the user, it flashes LED D4 (the activity indicator) and sends a feedback tone back over the phone line to let you know the command was received. Components R19, R21, Q6, C5, D10 and D11 work together with the micro-controller to generate the tone pulse. The pulsed tone output from U1:pin 11 is amplified from 0 to 5 VDC up to 0 to 12 VDC to ensure that enough signal will couple through to the phone line. Protection diodes D10 and D11 limit the incoming signal on the phone line (between +12.7 and - 0.7 V) so that potentially damaging voltages like the 90 Vp-p 'Ring' signal does not blow up Q6!

A detailed description of each of the configurations is provided later in this manual

The Power Supply

So far we have covered most of the circuitry on the board with exception of the power supply. VR1 and the surrounding parts C3, C4 and the polarity protection diode D1 form a simple voltage regulator to supply a steady 5 VDC to the ICs on the board. By using this scheme, we can operate the unit with a single 12 VDC (positive tip on J5) source and have access to the multiple voltages needed for the unit to operate.

DCI2C PARTS LAYOUT DIAGRAM



PARTS SUPPLIED WITH YOUR DCI2C KIT

Capacitors

- 2 22 pF disc capacitor (marked 22) [C7,8]
- 1 470 pF disc capacitor (marked 470 or 471) [C1]
- 2 .01µF disc capacitor (marked .01, 103 or 10 nF) [C2,6]
- 6 0.1 µF disc capacitor (marked .1 or 104) [C5,10,11,12,14,15]
- 1 10 µF electrolytic capacitors [C4]
- 1 100 µF electrolytic capacitors [C3]

Resistors

- 3 220 ohms (red-red-brown) [R11,18] [one spare for testing]
- 1 1K ohms (brown-black-red) [R3]
- 8 10K ohms (brown-black-orange) [R2,8, 9,10,19,20, 21, 23]
- 1 100K ohms (brown-black-yellow) [R4]
- 1 330K ohms (orange-orange-yellow) [R6]

Semiconductors and Integrated Circuits

- 1 1N4000 series diode (black body with white band) [D1]
-Note that 1N4002-1N4007 diodes may used.
- 4 1N4148 diodes (small glass diode) [D2,3,10,11]
- 2 2N3904 transistor (three leads TO-92 package marked 3904) [Q6, 7]
- 1 7805 +5 volt voltage regulator [VR1]
- 3 JUMBO red LED [D4,9] [one spare for testing]
- 1 68HC908JK3 pre-programmed micro-controller (20 pin DIP) [U1]
(marked with a sticker labeled DCI2rxx)
- 1 HT9170B DTMF decoder IC (18 pin DIP) [U3]
- 1 74HC154 4 to 16 line decoder (24 pin DIP) [U2]

Miscellaneous Components

- 1 2.1 mm DC power jack [J5]
- 1 RJ11 modular phone jack (PCB mount) [J6]
- 2 DPDT PC mount pushbutton switch [S1,2]
- 1 3.579 MHz crystal (Marked 3.579 or 3.579545) [X1]
- 2 #4-40x1 1/4" screws
- 4 #4-40x3/16" screws
- 2 black plastic switch caps
- 1 10 pin dual row header [J2]
- 1 20 pin dual row header [J1]
- 1 20 pin IC Socket
- 1 8" piece of 24AWG wire [for testing]
- 4 Rubber Feet
- 1 Case assembly (includes front panel, rear panel, top and bottom case shells)

RAMSEY "Learn-As-You-Build KIT ASSEMBLY

There are many solder connections on the DCI2C printed circuit board. PLEASE take us seriously when we say that good soldering is essential to the proper operation of your DTMF Controller Interface!

- Use a 25-watt soldering pencil with a clean, sharp tip.
- Use only rosin-core solder intended for electronics use.
- Use bright lighting; a magnifying lamp or bench-style magnifier may be helpful.

Do your work in stages, taking breaks to check your work. Carefully brush away wire cuttings so they don't lodge between solder connections.

We have a two-fold strategy for the order of the following kit assembly steps. First, we install parts in physical relationship to each other, so there's minimal chance of inserting wires into wrong holes. Second, whenever possible, we install in an order that fits our "Learn-As-You Build" Kit building philosophy. This entails describing the circuit that you are building, instead of just blindly installing components. We hope that this will not only make assembly of our kits easier, but help you to understand the circuit you're constructing.

For each part, our word "Install" always means these steps:

1. Pick the correct component with the proper value to start with.
2. Insert it into the correct PC board location.
3. Orient it correctly, following the PC board drawing and the written directions for all parts - especially when there's a right way and a wrong way to solder it in. (Diode bands, electrolytic capacitor polarity, transistor shapes, dotted or notched ends of IC's, and so forth.)
4. Solder all connections unless directed otherwise. Use enough heat and solder flow for clean, shiny, completed connections.
5. Trim or nip the excess component lead wire after soldering.

NOTE: Save some of the longer wire scraps nipped from resistors and capacitors. These will be used to form wire jumpers (JMP1, etc.) to be soldered in just like parts during these construction steps.

Although we know that you are anxious to complete the assembly of your

DTMF Controller kit it is best to follow the step-by-step instructions in this manual. Try to avoid the urge to jump ahead installing components.

Since you may appreciate some warm-up soldering practice as well as a chance to put some landmarks on the PC board, we'll first install some of the larger mounting components. This will also help us to get acquainted with the up-down, left-right orientation of the circuit board. Remember that all of the components will be mounted on the component side of the circuit board and soldered on the solder side of the circuit board (the side that contains the printed circuit traces). Have a look at the parts layout diagram to help with your assembly.

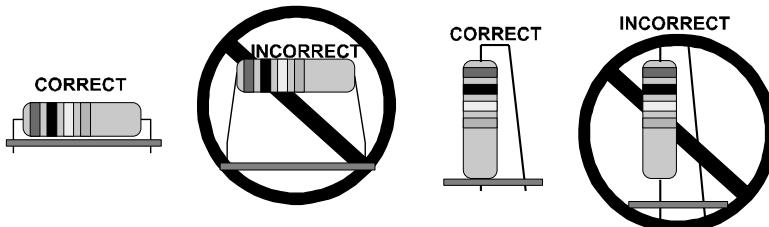
Use the boxes to check off your progress.

Check all received parts against the parts list. The parts list describes the various markings that may be found on the kit parts. Carefully sort the parts into small piles, (an empty egg tray does nicely for this purpose) to aid in finding the correct part at the required time.

Today's IC's have achieved remarkable performance levels and it is extremely unlikely that any of your chips will have problems, yet we know that some of our hobbyists insist on socketing all IC components. The addition of these will not "void" your warranty, but if a problem arises from a socketed component you will be required to pay the additional technician fee for labor in the repair of your kit, if necessary.

We will begin by installing the input and output connectors on the rear side of the circuit board. These will act as our landmark components and make the orientation of the rest of the parts a bit easier.

Proper Component Installation:



NOTE: All of the diodes and resistors used in the kit will be installed in a stand up fashion. This means one lead will go straight into the board while the other is bent around to go back down into the other hole. The straight lead goes into the hole with the silk-screened circle around it on the circuit board.

Enough of that ... let's get started!

DCI2C DTMF CONTROLLER INTERFACE KIT ASSEMBLY

First we'll install the two output connectors, J1 and J2. These are a 10 and 20 pin dual row connectors. They are installed on the back edge of the board with one row of pins on each side. There is a long and short side. Place the short side over the board edge and carefully align the pins with the silver solder pads. Make sure they are seated tight against the board and then solder one of the end pins. Check for proper alignment and then solder all remaining connections.

- 1. Install J1, the 10 pin connector as described above.
- 2. Install J2, the 20 pin connector as described above.

Next we'll install the resistors, one value at a time starting with the 10K ohm ones. You will notice that most of the resistors are installed in a vertical standing fashion. The resistors in your kit may not have the leads formed to install this way. Refer to the "Proper Component Installation" instructions in the previous section of this manual for instructions.

First find the 10K ohm (brown-black-orange) resistors.

- 3. Install R2, a 10K ohm resistor (brown-black-orange).
- 4. Install R19, a 10K ohm resistor (brown-black-orange).
- 5. Install R20, a 10K ohm resistor (brown-black-orange).
- 6. Install R23, a 10K ohm resistor (brown-black-orange).
- 7. Install R21, a 10K ohm resistor (brown-black-orange).
- 8. Install R8, a 10K ohm resistor (brown-black-orange).
- 9. Install R9, a 10K ohm resistor (brown-black-orange).
- 10. Install R10, a 10K ohm resistor (brown-black-orange).

Now find the 100K ohm resistor (brown-black-yellow).

- 11. Install R4, a 100K ohm resistor (brown-black-yellow).

Now find the 2, 220 ohm resistor (red-red-brown).

- 12. Install R11, a 220 ohm resistor (red-red-brown).
- 13. Install R18, a 220 ohm resistor (red-red-brown).

Now find the 1K ohm resistor (brown-black-red).

- 14. Install R3, a 1K ohm resistors (brown-black-red).

The last resistor you should have is a 330K ohm resistor (orange-orange-yellow)

- 15. Install R6, a 330K ohm resistor (brown-black-orange).

OK, that's it for the resistors, now we'll install the diodes. The resistors didn't matter which direction they were installed but diodes must be installed in the proper direction. You will notice there is a white band on the pattern on the circuit board. The diode's banded side **MUST** be installed so the end with the band matches the white line of the pattern.

Find the 1N4000 series diode. This should be a round black device with a white band on one end.

- 16. Install D1, a 1N400x series diode. Watch its orientation!

Next find the 4 1N4148 diodes. These are smaller than D1 and may be a copper color with a black band.

- 17. Install D2, 1N4148 diode. Watch its orientation!

- 18. Install D3, another 1N4148 diode. Watch its orientation!

- 19. Install D10, another 1N4148 diode. Watch its orientation!

- 20. Install D11, another 1N4148 diode. Watch its orientation!

Next we'll install two of the integrated circuits, a 74154, 4 tp 16 line decoder and U3 an HT9170 DTMF decoder. The microprocessor, U1 will be installed later.

- 21. Install U3, the 18 pin DIP tone decoder chip marked HT9170B. Make absolutely sure it is mounted in the proper direction. The small semi-circle (or notch as commonly called) on the IC represents pin 1 and should be mounted in the same direction as in the Parts Layout Diagram. The ICs in this kit are not mounted in the same direction so look closely before soldering it in.

- 22. Next install U2 the 74154 in the same way as U3. Make sure it is properly oriented before soldering all pins.

The next components we'll install are the ceramic capacitors. It doesn't matter what direction these are installed. First locate the 0.1uF capacitors marked 104.

- 23. Install C12, a 0.01uF capacitor (104)

- 24. Install C10, a 0.01uF capacitor (104)

- 25. Install C11, a 0.01uF capacitor (104)

- 26. Install C5, a 0.01uF capacitor (104)

- 27. Install C15, a 0.01uF capacitor (104)

- 28. Install C14, a 0.01uF capacitor (104)

Find the two 0.01uF ceramic capacitors marked 103

- 29. Install C2, a 0.01uF capacitor (103)
- 30. Install C6, a 0.01uF capacitor (103)

Find the two 22pF ceramic capacitors marked 22

- 31. Install C7, a 22pF capacitor (22)
- 32. Install C8, a 22pF capacitor (22)

The last ceramic capacitor you have should be 470pF marked 470

- 33. Install C1, a 470pF capacitor (470)
- 34. Install VR1, the 7805 voltage regulator. Install the three leads as shown on the silkscreen and gently bend the part over to match the silkscreen layout and then solder all three leads. This part “smoothes” out any ripple that may still be present on the main input supply voltage and provides us with the needed 5 VDC the ICs operate on.
- 35. Install Q7, a three leaded transistor marked 2N3904. The flat side must be placed as shown on the PC board silkscreen. Look at the Parts Layout Diagram for further clarification. When you insert it, mount it as close to the board as possible without forcing it.
- Install Q6, another 2N3904 transistor in the same way.
- 36. Identify and install the power connector J5, the 2.1 mm DC power jack at the edge of the PC board. Gently slide the leads through the component side of the circuit board until the connector is mounted flush. Solder all three connections using enough heat to flow the ground connection completely.
- 37. Install the 20 pin DIP socket for U1, the 68HC908JK1 micro-controller IC. It doesn't matter which way the socket is orientated, as long as the chip is place in the socket the correctly. You can bend two of the corner leads out slightly to hold the socket in place when you flip the board over to solder it in. Make sure all 20 pins are through the holes and then solder each one. Check your solder joints for even flow before moving on.

The next two capacitors are called electrolytic capacitors and it is very important they be installed in the proper direction. The pattern on the circuit board has a “+” printed near one of the lead holes. This indicates where the positive or “+” lead of the capacitor must be inserted. The capacitors usually have the negative lead marked with either /or a vertical stripe or “-” sign. The lead nearest this marking must be placed in the hole away from the “+” sign on the board. Yea I know, why didn't we/they mark things the same way? Well there is no real reason other than this is the way these components and circuit boards are usually made. To make it even more confusing, the capacitors sometimes have the positive lead marked, but this is usually not the case with the style of component used in this kit.

First locate the 100uF capacitor. It will be marked 100uF and may have a voltage rating of 25V or more. As long as the voltage is above 25 volts and capacitance is 100uF you're good to go.

- 38. Install C3, a 100uF capacitor, marked 100uF. Watch the orientation.

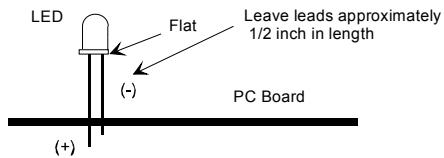
Next comes the 10uF capacitor. Again the 10uF is important and the voltage should be above 25 volts. Watch the orientation.

- 39. Install C4, a 10uF capacitor, marked 100uF. Watch the orientation.

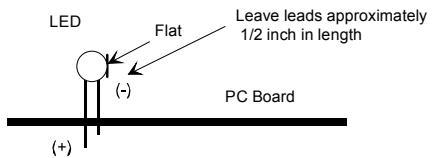
- 40. Install pushbutton switch S1 by inserting all six leads through the circuit board. The switch should fit flat to the circuit board before soldering.

- 41. Install S2 the same way.

- 42. Install LED D9. The flat side is oriented as shown in the diagram. Leave it standing about 1/2 of an inch off of the board when soldering. After soldering bend it over to a 90° angle at its midpoint so that it faces the outside of the board. Observe the following diagrams for proper orientation.



Front View



Front View after Bending

- 43. Install LED D4 the same way as D9.
- 44. Install X1, the 3.579 MHz crystal (silver can marked 3.579). Make sure it is flush to the board before soldering.
- 45. Install J6, the modular RJ-11 phone jack. Pay close attention to the silkscreen and line up the four conductor wires with their respective holes before snapping the part onto the board. Solder all four wire connections being careful not to short them together (they're really close to each other). Do not solder the plastic posts. The snap fit design will hold it in place.
- 46. Insert U1, the micro-controller marked with a sticker labeled DCI2rxx into the socket. Orient the notched end as shown on the PC board silkscreen and Parts Layout Diagram (toward the relays). Before you push it down into the socket, check to be sure none of the pins are bent under or outside of the socket. When you're sure the pins are where they belong, press the chip down so that it is seated flat within the socket.

Initial DCI2 Testing

Now it's time to do some basic testing to see if your DCI2 is operating properly. These tests will verify that the microprocessor and tone decoder circuits are functioning. In order to test the actual outputs you will need to make up a tester using the extra red LED and 220 ohm resistor included in the kit. We'll take you thru the procedure.

Tone decoder & microprocessor test

You will need to have a touch tone signal source connected to J6 in order to perform these tests. All you need to do is connect the DCI2 to your telephone line, Just like you connect a telephone, using a standard telephone connection cable. By lifting the phone receiver and pressing the phone's buttons the tones will be generated and the DCI2 will decode them. Don't worry about any tones or other things like your phone is off-hook or out of order type messages. The DCI2 will filter them out and ignore them. Once you have the DCI2 connected follow the steps below. It is important that you follow the steps exactly or the results may not be as indicated. Don't just start randomly pressing buttons. If the results indicated are not achieved, stop and go to the troubleshooting section of this manual.

1. Make sure both S1 and S2 are not pressed in.
2. Apply power to J5 of the DCI2 and turn it on by pressing S1. The power LED should light.
3. Connect the DCI2 phone line input, J6, to a telephone line using a standard RJ11 phone cord. Make sure there is a telephone set nearby also connected to the phone line.
4. Lift the phone and press the "4" button several times. The activity LED should flash each time you press the button and you will hear numerous beeps. If this works proceed to the next step. Otherwise you'll need to do some trouble shooting. See the troubleshooting section of this manual.
5. Turn the DCI2 off and back on and then lift the phone receiver and listen while pressing the "1" button. You should hear the Touch Tones, a single beep from the DCI2 and the "ACTIVITY" LED on the DCI2 should flash **TWO** times.
6. Now press the "#" button. The "ACTIVITY" LED should flash **ONCE** and you should hear another single beep.
7. Now press the "2" button. You will hear the Touch Tones, **TWO** beeps and the activity light will flash **THREE** times.
8. Now press the "#" button. The "ACTIVITY" LED should flash **ONCE** and you should hear another single beep.

Repeat steps 4 and 5 for each of the buttons on the phone. Each time you press a number you will hear the corresponding number of beeps in the phone and the "ACTIVITY" LED will flash the number pressed times plus one. You

MUST press the “#” button following each number button, otherwise there will be no confirmation of the number pressed until you press the “#” button.

If your phone has buttons labeled “A”, “B”, “C” and “D”, these buttons will correspond to 13, 14, 15 and 16 respectively.

The “#” button is a 12.

The “*” button is a special case and will respond with a high to low response tone. It is used to cancel a function and reset the system and to log out of secure mode. See the “DCI2 FUNCTIONALITY DESCRIPTION” section of the manual for further details.

Now that we’re sure the DCI2 is decoding the tones properly lets move on to checking the output signals. This is a little tricky but hang in there.

The first thing you need to do is locate the spare red LED and 220 ohm resistor included in your kit. We’re going to build a tester with them.

DCI2 Tester Construction

1. Using a pair of small pliers hold the long lead on the spare LED about $\frac{1}{4}$ ” away from the plastic case and carefully bend the lead so it forms a right angle with the case. Be sure to bend the lead with your fingers and not the pliers.
2. Strip a little insulation from both ends of the piece of wire in your kit.
3. Make sure all the fine strands of the wire are bundled together and apply some solder to each end to hold them together. This is called tinning the wire.
4. Solder one end of the wire to the lead you just bent on the LED and solder the other end to one lead of the spare 220 ohm resistor.
5. Locate the power LED, D9, located at the front of the circuit board to the right of the power switch, S1. The lead of D9 closest to S1 is the +5 volt power. You’re going to temporarily solder the other lead of the 220 ohm resistor to this point on the circuit board. A good way to do this is to first tin the resistor lead. Then apply a little extra solder to the connection on the circuit board. Now simply heat the connection and resistor lead together at the connection point.

Turn on the DCI2 and touch the unconnected led of the LED to terminal on the outside edge of the power connector J5. The LED should light. If it doesn’t make sure you have the LED connected properly and you the resistor is connected to the right point. The lead you are touching to the test point should be closest to the FLAT on the LED case.

OK, you now have a way to test the outputs of the DCI2. Testing will involve checking each output by touching the unbent lead of the LED to the output being tested. When the output is active the LED will light. This is actually the way we test the assembled units except we have a special fixture with an LED for each output. We didn’t think you would want to pay for the 21 LEDs and other items for the fixture. This way will work just fine.

DCI2 Output Testing

Your DCI2 is configured from the factory to operate in the non-secure, latched mode for the BCD output so that will make things easy to test. If for some reason you have reconfigured the unit to operate in some other state we suggest you reset the configuration to the default state. See the "CONFIGURATION ENTRY SEQUENCES" table in the "Configuring Your DCI2" section of this manual.

You will need to refer to the "Full DTMF Configuration Signals" and "4 to 16 Line Signal Outputs" tables in the "OUTPUT SIGNAL DESCRIPTION" section to perform output testing. Make sure you have the phone line or other touch tone signal source connected to the DCI2 and the unit is turned on. First we'll test the 16 line outputs on J1 and then move to the BCD output on J2.

16 Line Output Testing

Using the LED tester you just made hold the test lead on J1 pin 14, the Valid Data signal and touch any button on the phone. The LED should light each time a button is pressed.

Now, referring to the "4 to 16 Line Signal Outputs" table, touch the LED to the signal pin on J1 for each of the decoded outputs and press the corresponding tone. The LED should light for each entry.

BCD Output Testing

1. First reset the DCI2 by turning it off and back on.
2. While holding the test LED on pin 9 of J1, the Valid Data signal, press "1" and then "#". The LED should flash one time after the "#" is pressed.
3. Using the LED tester refer to the "Full DTMF Configuration Signals" table test each of the 4 BCD output pins, (1, 3, 5, 7) on J1. For the number "1"/#" sequence entry the LED should light when touched to pins 7, 5, and 3 and should not light on pin 1.
4. Now press "2" and then "#". You should hear the confirmation tones in the phone and see the activity light flash just like you did in the initial testing steps.
5. Using the LED tester refer to the "Full DTMF Configuration Signals" table and test each of the 4 BCD output pins, (1, 3, 5, 7). For the number 2 button being pressed the LED should light when touched to pins 7, 5, and 1 and should not light on pin 5.
6. Repeat step 5 for each of the buttons and refer to the "Full DTMF Configuration Signals" table. The LED should light on each pin that indicates a value of "0" in the table for pins 1, 3, 5 and 7 on J1.
7. You can now remove the 220 ohm tester resistor you soldered to the D9 connection for testing purposes.

That's it. If all the tests were successful your DCI 2 is ready to be put in it's case and is ready for use. Proceed to the next section to finish your DCI2 kit. If you encountered any problems please check your work over carefully for misplaced components, bad solder connections and solder bridges. If you still have problems our tech support department will be able to help you find the problem. Give us a call and we'll be glad to help you.

Case Assembly

- 1. Locate the case bottom. The bottom can be identified by the board mounting post on the inside and the holes for the case screws on the outside.
- 2. Locate the four rubber feet. Place one in each corner of the outside case bottom. They should be located 1/2 inch in from the side and 1/2 inch in from the front or back opening.
- 3. Note that there is a plastic post located near one corner of the case bottom. Locate the Front Panel and slide it into the opposite end of the case of the case bottom from where the post is located.
- 4. Press the two black switch caps onto the shafts of switches S1 and S2.
- 5. Place the circuit board into the case bottom so that the two push buttons pass thru the front panel. Use the four #4-40x1/4" Phillips Head screws to attach the case bottom.
- 6. Carefully bend the leads for D9 and D4 LED's so they pass thru the "POWER" and "ACTIVITY" holes in the front panel.
- 7. Locate the Back Panel and slide it into the case bottom at the back of the board.
- 8. Place the top cover over the bottom case assembly, sliding the front and rear panels over the front and rear panels. Notice that there is a front and rear to the top cover. Make sure it is properly oriented and fasten them together using the 2 4/40 x 1 1/4 inch screws.

DCI2 FUNCTIONALITY DESCRIPTION

The DCI2 is configurable by the user to operate as either a FULL DTMF 16 tone decoder or an interface to the DVMS. Both configurations have security capability. In DVMS mode only 8 messages are available.

In FULL DTMF mode 4 binary coded lines are provided along with a data valid line. In this mode the data lines may be configured to either remain latched or to activate and return to a high state when a valid DTMF tone is detected. A data valid signal is also provided to indicate when valid data is present. All data lines are active low and the data valid is a low going pulse which occurs when the data is set on the lines.

In DVMS Mode three lines are provided with a binary code along with message play and stop control lines. Latching of any data is prevented in this mode.

Full DTMF continuous decoding is also provided in either DVMS or FULL DTMF mode. A 1 of 16 line output (active low) and a data valid line (active high) is provided independent of the DCI2 configuration. The lines activate only during presence of a tone. Otherwise they are at a high state for the data and low for the data valid line. This is done entirely in hardware. No software code is involved.

In secure configuration modes a 1 minute window is provided after the last activity at which point security will expire. Security also expires upon entry of a "*" in any mode except programming.

Configuration is accomplished by activating the PROG switch on initial power up, entering the configuration desired, releasing the PROG switch and cycling the power. Note that ALL positions MUST be entered in the proper sequence during programming.

Default configuration for a virgin programmed processor is full binary, latched, no security.

A more detailed description of the data lines is provided later in this manual

Configuring Your DCI2

The DCI2 is configured at the factory to operate as a full DTMF decoder in a non-secure mode. This makes it easier for you to troubleshoot immediately after you have completed assembly. Of course being the excellent kit builder you are there should be no problems but just in case we made it easy to trouble shoot. Simply follow the steps below and you should have no problems.

Note that the acknowledgment tone is a high pitch tone. If an invalid entry is made a "RASPBERRY" or lower pitch tone will be heard. If an invalid entry is made you may continue the programming at the current point by making a correct entry or turn your DCI2 off and back on and start over.

- To begin programming it is necessary to start from a fresh power up so press the power switch in to turn on your DCI2.
- Press the programming button. The ACTIVITY indicator will light.
- The first entry sets the output mode.
 - Press "*" for DVMS (Digital Voice Messaging System)
 - OR
 - Press "#" for full BCD output mode
 - The ACTIVITY LED should now be off
- The next entry determines if the output is latched after DTMF entry or active only when a DTMF tone is present. Note that for DVMS mode operation only the non-latched mode is available and any valid DTMF entry may be made.
 - Press "*" for non-latched operation
 - OR
 - Press "#" for latched operation
 - The ACTIVITY LED should flash with a valid entry.
- Press "#". An acknowledgment tone should be heard and the ACTIVITY LED should light to indicate the DCI2 is ready for entry of a security code.
- You will now make four(4) entries as indicated below. Any DTMF entry may be used. Note that the "*" and "#" keys have special functions and should not be used in your security code entry except as indicated below.
 - If no security is desired enter a "#" four(4) times.
 - If security is desired enter any four(4) DTMF entries of 0 – 9 and A – D. DO NOT USE THE "*" OR "#" KEYS.
 - The ACTIVITY LED should turn off after the first entry and flash with each of the next 3 entries entry.
- After the last security entry is made an acknowledgment tone will be heard and the ACTIVITY LED will begin to flash. This indicates completion of programming.
- Now release the PROGRAMMING switch.
 - The ACTIVITY LED will turn on and then off and an acknowledgement tone will be heard indicating exit of the PROGRAMMING MODE.

It is now necessary to turn your DCI2 off and back on to start your DCI2 in the new configuration. The new configuration will be load on all future start ups until a new configuration is programmed.

CONFIGURATION ENTRY SEQUENCES

CONTROL TYPE	LATCH	SECURITY	COMMENTS
* (DVMS)	*	# (beep) + 4digit	DVMS, no latch, secure
* (DVMS)	#	# (beep) + 4digit	DVMS, no latch, secure
# (full BCD)	*	# (beep) + 4digit	FULL BCD, no latch, secure
# (full BCD)	#	# (beep) + 4digit	FULL BCD, latch, secure
* (DVMS)	*	# (beep) + #####	DVMS, no latch, non-secure
* (DVMS)	#	# (beep) + #####	DVMS, no latch, non-secure
# (full BCD)	*	# (beep) + #####	FULL BCD, no latch, non-secure
# (full BCD)	#	# (beep) + #####	FULL BCD, latch, non-secure
# or *	# or *	# (beep) + *###	Set to factory default (full BCD, latch, no Security)

KEY

CONTROL TYPE ----- * = DVMS
 # = FULL BCD
 LATCH ----- * = NO LATCH

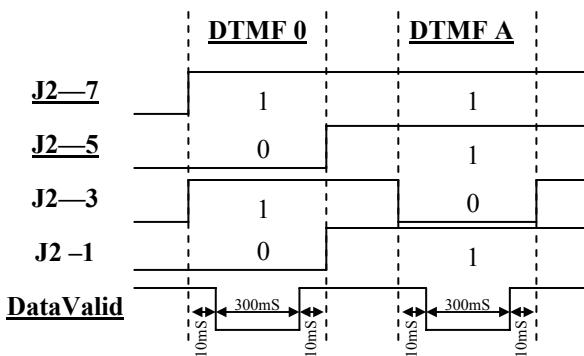
OUTPUT SIGNAL DESCRIPTION

This section describes the various outputs of the DCI2.

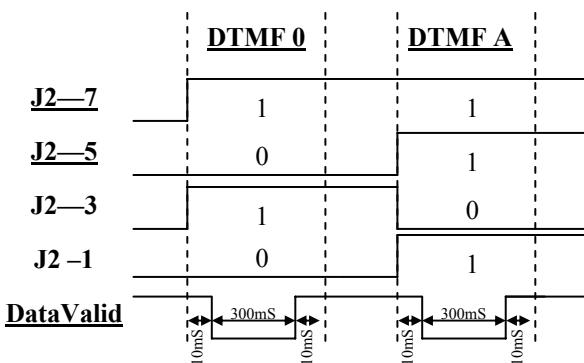
Full DTMF Configuration

Note that the Data Valid signal, J2 pin 9 , for the Full DTMF configuration is a low pulse. In the non-latched configuration when valid data is detected the 4 data lines are set, data valid is pulsed low and the data lines are then all set high. In the latched configuration when valid data is detected the 4 data lines are set, data valid is pulsed low and data lines will remain set until the next valid DTMF tone is detected.

NON-LATCHED TIMING



LATCHED TIMING



Full DTMF Configuration Signals

<u>DTMF Tone</u>	<u>4-bit Code</u>	<u>J2 Pin 9 Data Valid</u>	<u>J2 Pin 7</u>	<u>J2 Pin 5</u>	<u>J2 Pin 3</u>	<u>J2 Pin 1</u>
1	0001	0	0	0	0	1
2	0010	0	0	0	1	0
3	0011	0	0	0	1	1
4	0100	0	0	1	0	0
5	0101	0	0	1	0	1
6	0110	0	0	1	1	0
7	0111	0	0	1	1	1
8	1000	0	1	0	0	0
9	1001	0	1	0	0	1
0	1010	0	1	0	1	0
*	1011	0	1	0	1	1
#	1100	0	1	1	0	0
A	1101	0	1	1	0	1
B	1110	0	1	1	1	0
C	1111	0	1	1	1	1
D	0000	0	0	0	0	0
NO TONE (no latch)	1111	1	1	1	1	1
NO TONE (latched)	xxxx	1	1/0	1/0	1/0	1/0

DVMS Configuration

The DVMS configuration is specifically designed to operate in conjunction with the Ramsey Digital Voice Message System (DVMS) message recorder/player. You may use this for other purposes but it's primary purpose is for control of the DVMS. The table below defines the signals you can expect on J2. Note that only 1 to 8 and the "#" and "*" DTMF tones are valid for control purposes.

DVMS Configuration Outputs

<u>DTMF TONE</u>	<u>FUNC-TION</u>	<u>J2 Pin 9 (DVMS DB25-25)</u>	<u>J2 Pin 7 (DVMS DB25-13)</u>	<u>J2 Pin 5 (DVMS DB25-10)</u>	<u>J2 Pin 3 (DVMS DB25-11)</u>	<u>J2 Pin 1 (DVMS DB25-12)</u>
1	Msg 1	1	1	0	0	0
2	Msg 2	1	1	0	0	1
3	Msg 3	1	1	0	1	0
4	Msg 4	1	1	0	1	1
5	Msg 5	1	1	1	0	0
6	Msg 6	1	1	1	0	1
7	Msg 7	1	1	1	1	0
8	Msg 8	1	1	1	1	1
#	Play	1	0 (pulse)	Msg #	Msg #	Msg #
*	Stop	0 (pulse)	1	n/a	n/a	n/a

4 to 16 Line Decoder Output

The 4 to 16 line decoder output signals are located on output connector J1. These signals are active at all times and are independent of the DCI2 configuration. A single line corresponding to the valid DTMF tone is driven low while the tone is detected. If no valid tone is present all lines are at a logic high. All lines are open collector logic levels and with a logic 0 being at ground level and a 1 being an open. A pull-up is required on all outputs. Note that these are logic levels and can drive simple low current loads such as an LED. Higher current loads require use of a higher current driver. We have provided some suggested driver circuits in the "Wiring And Custom Applications Suggestions" section of this manual.

4 to 16 Decoder Signal Outputs

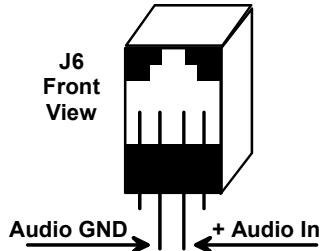
<u>DTMF Tone</u>	<u>J1 Pin Low</u>	<u>J1 Pin 14 Valid Data</u>
1	17	0
2	15	0
3	13	0
4	11	0
5	9	0
6	7	0
7	5	0
8	3	0
9	1	0
0	2	0
*	4	0
#	6	0
A	8	0
B	10	0
C	12	0
D	19	0
NO TONE	All ABOVE ARE HIGH	1

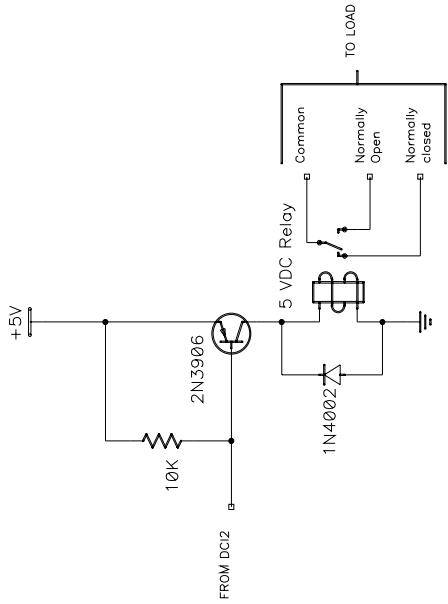
WIRING AND CUSTOM APPLICATION SUGGESTIONS

All of the output lines of the DCI2 operate at a 5VDC logic level. This means that some type of interface is required if you want to control anything other than a simple device such as an LED indicator. Don't panic!! It is not difficult to control just about any type of device with the DCI2. We have supplied a few examples that should get you on your way to controlling the real world.

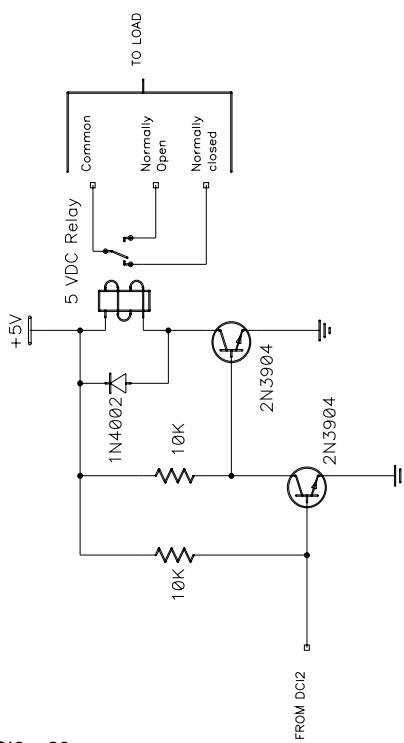
Line Level Audio Input Wiring:

-Custom Audio feed wiring arrangement using a standard RJ-11 Patch cable.

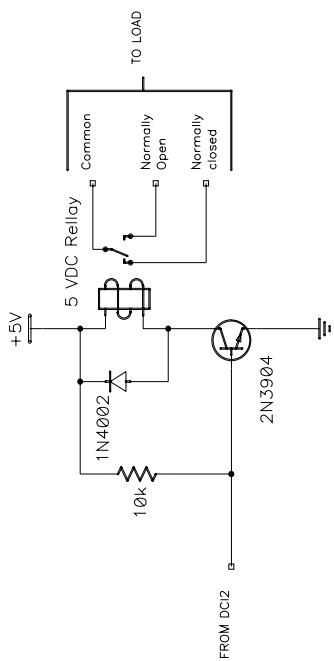




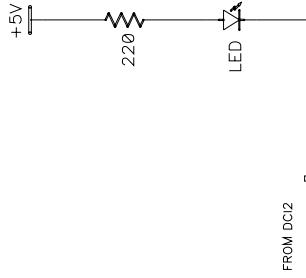
High input activates relay



Low input activates relay



High input activates relay



Low input turns on LED

TROUBLESHOOTING GUIDE

If your DCI2C does not work at all, recheck the following:

- correct orientation of U1 and U3 (see PC board Parts Layout Diagram)
- correct polarity of all electrolytic capacitors.
- correct orientation of all diodes (especially D1).
- all solder connections
- jumper wires at all JMP locations.
- Have another set of eyes look over your work. Here at the shop we have often run into a "stone wall" on a problem only to have a fellow technician see our obvious error. It is sometimes very difficult to see your own mistakes

Still having trouble?

While we had hoped that it wouldn't come to this, if you are still having trouble with your DCI2, here are a few additional suggestions.

PROBLEM: The Power LED (D9) doesn't light and VR1 gets very hot quickly.

SOLUTION: You likely have a short across the power supply or you have a component placed in the incorrect orientation. Check all of your parts to make sure they correlate with those on the Parts Layout Diagram.

PROBLEM: The Power LED (D9) doesn't light and VR1 remains cool.

SOLUTION: Using an oscilloscope or a frequency counter to verify that there is a 3.579 MHz signal on pin 7 of U3 and pin 3 of U1. It should be approximately 0.5 Vp-p or greater. If you cannot check the oscillator, verify that 5 Volts DC is present on the IC power pins (U1:5 and U3:18). If not, check VR1 for 5 VDC output with at least 12 VDC input from your power supply.

PROBLEM: It seems to be missing key entries when I try to enter commands.

SOLUTION: Wait until after the confirmation tones have stopped before entering new commands.

PROBLEM: My answering machine hangs up before I finish my commands.

SOLUTION: Some answering machines will hang up automatically if they do not sense any voice activity. Try talking into the phone at the same time to provide the needed audio for it to hold the line. Example: Say "relay #1 ON" at the same time you are typing the commands. Some answering machines may not be compatible.

PROBLEM: It keeps giving me an error tone and it doesn't do what I want.

SOLUTION: Press * to reset the system. Then repeat your security code and command string. More than likely you just wound up out of synch with the DCI2 so you are not entering the data it is looking for. When in doubt, press the * button to reset the command entry algorithm back to a known state.

PROBLEM: I forgot my security code!

SOLUTION: No problem, just follow the instructions in the Using Your DCI2 DTMF Controller Interface section to program a new one.

PROBLEM: I'm trying to feed audio into the J6 input but it doesn't work.

SOLUTION: Depending on your audio level, you may need to replace R10, a 10K ohm resistor (brown-black-orange), with a jumper wire to connect it directly to ground. This will increase your audio levels if needed.

DCI2C DTMF CONTROLLER INTERFACE SPECIFICATIONS

Here are few of the commonly requested specifications for the DCI2C:

J5 Power Input

- Input working voltage range: 12 - 15 VDC
- Max DCI2C current draw is between 200 - 250 mA.

J6 DTMF Audio Input

- Signal Level = -29 to 1 dBm
- Dial Tone Tolerance = 10 dB
- Noise Tolerance = -12 dB
- Third Tone Tolerance = -16 dB
- Frequency Deviation Acceptance = +- 1.5%

Miscellaneous Information

- PCB Dimensions: 4.7" L x 4" W (max component height: 0.9")

CONCLUSION

We sincerely hope that you enjoy the use of this Ramsey product. As always, we have tried to compose our manual in the easiest, most user-friendly format that is possible. As our customers, we value your opinions, comments, and additions that you would like to see in future publications. Please submit comments or ideas to:

Ramsey Electronics, LLC
Attn. Hobby Kit Department
590 Fishers Station Drive
Victor, NY 14564

Please also feel free to visit our Website at www.ramseykits.com and offer your observations to other kit enthusiasts as well.

And once again, thanks from the folks here at Ramsey!

NOTES

NOTES

THE RAMSEY KIT WARRANTY

1. GENERAL:

Notice that this is not a "fine print" warranty. We want you to understand your rights and ours too! All Ramsey kits will work if assembled properly. The very fact that your kit includes this new manual is your assurance that prior to release of this kit, a varied group of knowledgeable people have assembled this kit from scratch using this manual. During this process, changes and additions are noted by each assembler and integrated into the final version of the manual...which you have! If you need help, please read through your manual carefully, all information required to properly build and test your kit is contained within the pages! However, customer satisfaction is our goal, so in the event that you do have a problem, please note the following:

2. DEFECTIVE PARTS:

It's always easy to blame a part for a problem in your kit. Before you conclude that a part may be bad, thoroughly check your work. Today's semiconductors and passive components have reached incredibly high reliability levels, and it's sad to say that our human construction skills have not! But on rare occasions a sour component can slip through. All of our kit parts carry the Ramsey Electronics Warranty that they are free from defects for a full ninety (90) days from the date of purchase. Defective parts will be replaced promptly at our expense. If you suspect any part to be defective, please mail it to our factory for testing and replacement. Please send only the defective part(s), not the entire kit. The part(s) MUST be returned to us in suitable condition for testing. Please be aware that testing can usually determine if the part was truly defective or damaged by assembly or usage. Don't be afraid of telling us that you "damaged it" or "burned it out", we're all human and in most cases, replacement parts are very reasonably priced. Remember, our goal for over three decades is to have a happy customer, and we're here to work WITH you, not AGAINST you!

3. MISSING PARTS:

Before assuming a part value is missing, check the parts listing carefully to see if it is a critical value such as a specific coil or IC, or whether a RANGE of values is suitable for the component (such as a "100 to 500 uF capacitor"). Often times, common sense will solve a mysterious missing part problem. If you're missing five 10K ohm resistors and received five extra 1K resistors, you can pretty much be assured that the "1K ohm" resistors are actually the "missing" 10 K parts ("Hum-n-m, I guess the orange band really does look red!") Ramsey Electronics project kits are packed with pride in the USA by our own staff personnel. While separate QC checks are made on all product kits, we too are human, and once in a great while there is a chance something can get through those checks! If you believe we packed an incorrect part or omitted a part clearly indicated in your assembly manual for your Ramsey kit, please contact us with information on the part you need. Contact our Repair Department via telephone, email or writing. Please have your invoice number and date of purchase handy.

4. REFUNDS:

All Ramsey products, kit or factory assembled units have an unconditional 10 day (from the date of purchase) return policy to examine our products. If you are not satisfied for any reason, you may return your unassembled kit with all the parts and instructions, or your factory assembled and tested product, together with your proof of purchase to the factory for a full refund less shipping. The return package should be packed securely. Insurance and tracking is highly recommended. A reminder, this applies to unassembled kits. They must be in the same new condition as received, not partially assembled! Assembled kits cannot be returned for credit. No RMA's are required; simply return to Ramsey Electronics LLC, Attn: Product Returns, 590 Fishers Station Drive, Victor, NY, 14564. If you have any questions, please contact us at 585-924-4560.

5. FACTORY REPAIR OF ASSEMBLED KITS:

Most of us at Ramsey are technically oriented and we do realize that things happen! Even following the best practices, with all of the best intentions, there is that chance that your kit doesn't work when you have completed it. Each manual goes into detailed troubleshooting based on the specific kit to help you troubleshoot the problem. We have found that 95% of returned kits involved wrongly installed components (wrong part or backwards polarity). This section of the warranty assumes you have gone through all those steps, and have now reached the point that you need to send it back.

To qualify for factory repair of customer assembled kits, the following conditions apply:

1. Kits must not be assembled with acid solder flux
2. Kit boards or circuits must not be modified in any manner from the version received
3. Kits must be fully assembled, not partially assembled. Our warranty does not include "finishing" your kit!
4. Must include a full description of the problem encountered including the troubleshooting steps you have already done.
5. Must not include non-standard, non-Ramsey accessories, cases, enclosures, knobs, etc. or any batteries.
6. Must include the minimum repair fee of \$25 USD in the form of check, money order or credit card authorization.
7. Ramsey Electronics, LLC reserves the right to refuse any repair due to excessive errors in construction methods.
8. If, due to customer construction methods, the repair is estimated to exceed the minimum flat rate, Ramsey Electronics, LLC will contact the customer to discuss the repairs needed and to receive authorization and payment for repair prior to repair.
9. In the unlikely case that a defective part is found to be the cause of the problem, the repairs will be made at no-charge to the customer, and any payments received for repair will be returned or credited back to the customer.
10. Properly pack your kit, insure the package, and use a carrier that can be tracked. Ramsey Electronics, LLC is not responsible for any loss or damage in shipment. Send the package together with your repair fee to the return address below. No RMA is required.

6. FACTORY REPAIR FEES:

Please understand that our Tech Support Group personnel are not volunteers! They are a dedicated group of highly trained technicians each configured with a very properly equipped test bench. Upon receipt of a repair, the setup, testing, diagnosis, repair, paperwork, and repacking of your kit requires nearly an hour of their time regardless of the size or complexity of the kit! The minimum repair fee represents 1/2 hour Tech Support time at \$50/hour USD. We try to keep all kit repairs within the realm of the \$25 flat rate whenever possible...and trust us; we exceed that time spent on most kits received more often than not!

7. CONTACT INFORMATION AND RETURN ADDRESS:

Technical Questions

RAMSEY ELECTRONICS, LLC
Attn: Tech Support
590 Fishers Station Drive
Victor, NY 14564
585-924-4560; 585-924-4886 Fax
techsupport@ramseyelectronics.com

Product Repair & Returns

RAMSEY ELECTRONICS, LLC
Attn: Repairs
590 Fishers Station Drive
Victor, NY 14564
585-924-4560; 585-924-4886 Fax
repairs@ramseyelectronics.com

Quick Reference

Parts Layout Diagram.....	7
DCI2C Assembly	11
Initial Testing	15
Schematic Diagram	18
Case Assembly.....	20
Configuring Your DCI2	21
Configuration Sequence Tables	23,25
Output Signal Description.....	24
Wiring & Custom Applications	28

REQUIRED TOOLS

- Soldering Iron
- Thin Rosin Core Solder
- Needle Nose Pliers
- Small Diagonal Cutters

ADDITIONAL SUGGESTED ITEMS

- Helping Hands Holder for PC Board/Parts
- Desoldering Braid

<u>TOTAL SOLDER POINTS</u>	
190	
<u>ESTIMATED ASSEMBLY</u>	
<u>TIME</u>	
Beginner	3.5 hrs
Intermediate	2 hrs
Advanced.....	1.5 hrs



RAMSEY ELECTRONICS, LLC
590 Fishers Station Drive
Victor, New York 14564
Phone (585) 924-4560
Fax (585) 924-4555
www.ramseykits.com

Price: \$5.00
Ramsey Publication No. MDCI2
Assembly and Instruction manual for:
RAMSEY MODEL NO. DCI2C
DTMF Controller Interface Kit